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THE HESSIAN FLY IN ONTARIO.

BY WM. LOCHHEAD, M.A., M.S., PROFESSOR OF BIOLOGY AND GEOLOGY,
ONTARIO AGRICULTURE COLLEGE, GUELPH.

The Hessian-fly is not a new pest in Canada. A search among the records shows that it was present in 1805, 1816, 1846 1857, and from 1877-1884. In the early fifties, along with the wheat midge, it caused an almost complete failure of the wheat crop in Ontario and Quebec. In 1856, the Government offered prizes of £40, £25, and £15 for the best essays on "The Origin, Nature, and Habits, and the History of the Progress from Time to Time, and the Causes of the Progress of the Weevil, Hessian Fly, Midge, and such Other Insects as have made Ravages on the Wheat Crops in Canada, and on Such Diseases as the Wheat Crops have been subjected to, and on the Best Means of evading or guarding against them." The first-prize essay, prepared by Prof. Hinde, of Toronto, was printed by the Government, and largely distributed in the country sections. The ravages of the Hessian Fly about 1878 were felt over the larger portion of the Province of Ontario, and in some sections the growing of wheat was discontinued for two or three years.

The recent outbreak dates from 1899. In that year, the south-western counties suffered to some extent; but the amount of damage done in each of the past two seasons far exceeds that in 1899. All counties south of the main-line of the Grand Trunk Railway running from Toronto to Sarnia are badly infested. Over this large area, the infestation is greatest in the counties bordering on Lake Erie and in the valley of the Thames, where the fall wheat is almost a total failure.

The Hessian Fly is generally supposed to have been introduced into America by the Hessian soldiers during the Revolutionary War. There is no trace of its presence on this continent prior to 1778, when it was noticed at New York. It may be safely inferred that as its food plants, wheat, barley, and rye were introduced from the East, the native home of the Hessian Fly was also in the East, probably Western Asia. At present the Fly is widely distributed through North America and Europe.

LOSSES BY THE HESSIAN FLY IN ONTARIO.

The average production of wheat in Ontario during the past five years has exceeded 25,000,000 bushels per year, with a value not less than \$16,000,000. On the supposition that the infested area ordinarily produces one-fifth of the total yield of wheat in the Province, and that the ravages of the Hessian Fly during 1901 in the same area have destroyed fully two-thirds of the average crop, then it must be conceded that the actual money lost exceeds \$2,000,000. To this loss must be added the loss of barley and rye crops caused by the same pest. This is no small amount; for the average production of these crops in Ontario during the last five years has not been much below a total of 20,000,000 bushels, worth in round numbers \$10,000,000. It is probable, then, that the total loss caused by the Hessian Fly in the Province of Ontario in 1901 will not fall below \$2,500,000.

DESCRIPTION.

Thomas Say, an American, published the first description of the fly in 1817, and gave it the scientific name of *Cecidomyia destructor*.

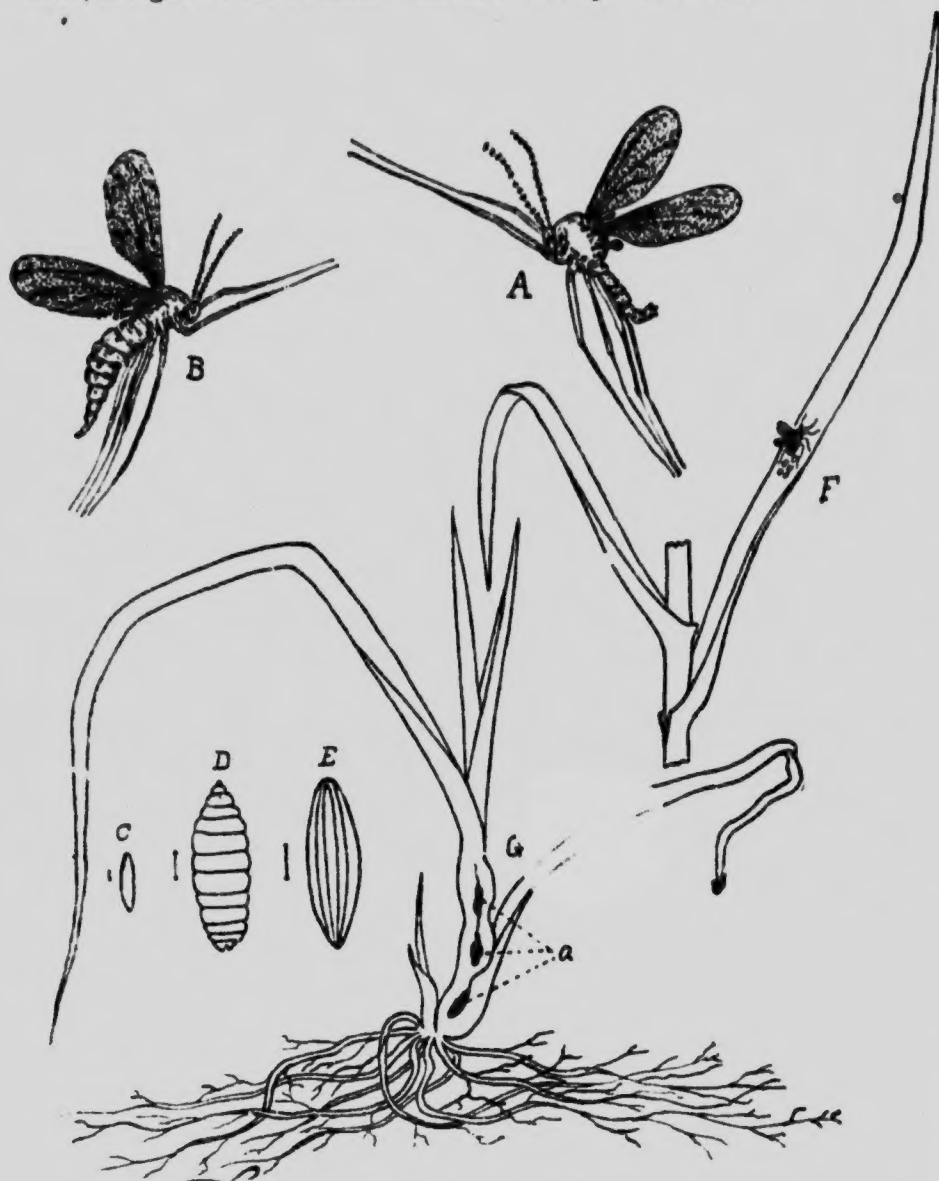


Fig. 1.—A, male Hessian Fly, much enlarged; B, female, also much enlarged; C, egg; D, maggot; E, flaxseed stage; F, piece of stalk showing fly, natural size, laying eggs; G, stalk of wheat injured at a, by the fly. The fine lines beside C, D, and E show the true length of these stages, the drawings being enlarged. (Modified from Riley.)
(Bulletin 46, Penn. Dept. of Agriculture, Harrisburg, Pa., by Dr. H. T. Fernald.)

There are four distinct stages in each generation of this insect, viz., the egg, the larva or maggot, the pupa, and the adult. 1. The adult insect is a

small two-winged fly, about half the size of the common mosquito, which it closely resembles. (Fig. 1). The female is larger than the male, being about one-tenth of an inch long, and dark in color. The legs are quite long, and the wings smoky black. 2. The eggs are one-fiftieth of an inch in length, spindle-shaped, and reddish. 3. The maggot or larva passes through three distinct stages during its development. During the first stage, it travels from the egg from which it hatches, down the leaf to the next joint. During the second stage it is fixed to the stalk, where it feeds on the juices of the plant. When full grown the maggot of this stage is about one-eighth of an inch in length and of a transparent, white color. The third stage is passed in the so-called "flaxseed" state formed by the cast-off skin of the second stage. In this stage the insect is harmless. The critical periods of the insect's life, viz., the hot, dry summer and the cold winter, are passed in the flaxseed condition. The maggot of the "flax seed" has a peculiar "breast bone" (Fig. 2), the function of

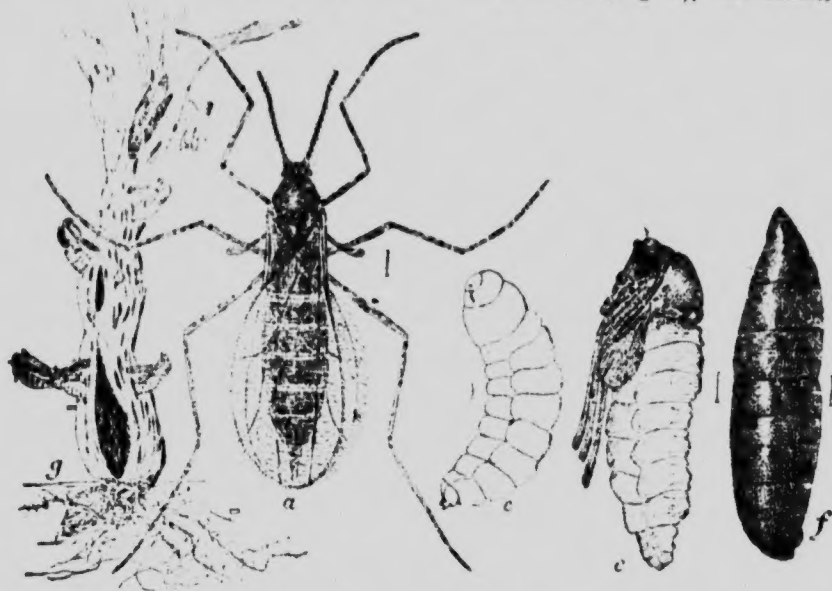


Fig. 2.—Different stages in the life of the Hessian Fly: a, female fly; b, larva or maggot; c, pupa formed inside the "flaxseed"; d, puparium or "flaxseed"; e, infested wheat stem, showing emergence of pupae and adults; all much enlarged; the hair-lines beside the figures indicating their natural size. (Adapted from Marlatt.)

which is probably to enable the maggot to reverse its position; for up to this time, it has been resting, head downward; but now it turns around and rests, head upward. 4 The pupa is rosy-colored and has a pointed beak, by means of which it cuts open the pupa case when it emerges as an adult or full-fledged two-winged fly.

LIFE HISTORY.

In the Peninsula of Ontario, there are two generations, or broods, each year. Commencing with the fall brood, we find that the adult female deposits from a few to thirty or more eggs on the upper surface of the leaf of the young wheat plant which has just emerged from the ground. In ordinary seasons, if there has been rain in the second or third week in August, egg-laying is

done the last week of August and the first week of September ; but weather conditions may retard the escape of the "flax-seeds," so that egg-laying may take place almost two weeks after the normal period. Such conditions occurred the last two seasons, when drouth prevailed throughout the month of August, and mild weather continued long into the fall. The result was the deposition of eggs as late as the 20th of September, a date nearly two weeks later than usual.

The eggs hatch in about four days after they are deposited, and the maggots forthwith begin to move down the leaf and stem within the leaf sheath, to the base of the plant in the case of the fall brood, but to the first joint above the ground, in the case of the spring brood. The maggot soon becomes fixed or imbedded in the stem, where it remains for about three weeks before changing into the "flax-seed" stage. In Ontario this stage is entered upon usually about the end of September, in which condition it remains all winter and early spring. About the 1st of May, it becomes a pupa, but soon the fly emerges to lay the eggs of the spring brood. (Fig. 2, g). The maggots of the spring brood are usually all in the flax-seed stage by the 10th or 15th of June, in which condition they remain until about the end of August. (Fig. 3).

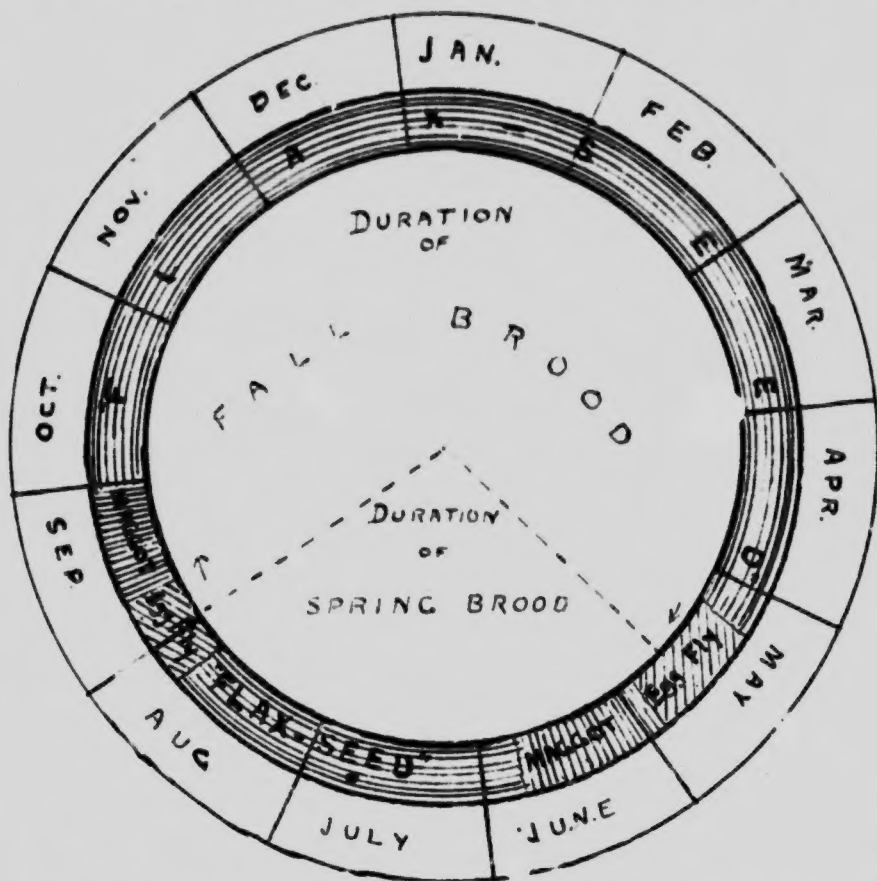


Fig. 3.—Diagram showing the life-history of the Hessian Fly and the duration of the two broods. (Original.)



Fig. 4.

Unaffected Wheat Plant. Youngest leaf as it unfolds and pushes upward is tubular and spindle-shaped. (After Webster).



Fig. 5.

Affected Wheat Plant. Spindle-shaped central shoot having been destroyed is absent; leaves are broader, darker green, more vertical and bunchy. (After Webster).

The life-time of the adult fly is short, lasting only the few days necessary for the deposition of the eggs. If mating occurs promptly, the life of the fly may not be longer than a few hours. A knowledge of this fact is of some importance; for within a few days after the adults are seen in any large numbers, it may be considered safe to sow wheat.

The following observations of the spring brood were made at Guelph:

Adult flies in large numbers on May 10th and 11th;

Eggs seen on the leaves of wheat plants from May 15th to 20th;

Maggots first seen at first joint above the ground the last days in May;

All the maggots in the "flax seed" stage by June 20th.

In the southern wheat districts, there are *supplemental* broods of the Hessian Fly, one following the usual spring brood and another preceding the usual fall brood. As a rule, however, these supplemental broods are unimportant in our northern wheat districts, but under abnormal conditions they may become somewhat troublesome and difficult to treat. It is very probable that it is through these supplemental broods that the pest manages to persist in most of the wheat growing districts, in spite of the destruction of the spring and fall broods.

When wheat is attacked in the fall, close observers notice that the leaves are darker green in color for a while, due no doubt to the stimulus given by the maggot to the tissues while embedding itself in the stalk, causing a broadening of some of the leaves and a deeper green. Soon, however, the plants begin to assume a brown tinge, followed by a yellowish color, indicating the death of the stalks and leaves affected.

The appearance of plants attacked by the spring brood is quite characteristic. As the flax-seeds are usually situated just above the first joint next the ground, the stalks bend abruptly at the point attacked, and near harvest time they are usually broken off. The heads are small, the grain is small or shrunken, and the crop is scarcely worth harvesting.

ENEMIES OF THE HESSIAN FLY.

In my studies of the Hessian Fly this year, I made an effort to determine the number of parasitic insects which were preying upon the pest, but

unfortunately very few could be found. This scarcity of parasites, it seems to me, is rather startling, for it means that there will be no material reduction in the numbers of the Hessian Fly for the coming season. It may be that the hundred or more samples of affected wheat stems procured from different parts of the infested area, were not fair samples, as not more than two per cent. of the "flax-seeds" under my observation were parasitized. This is a small percentage, when we take into account the fact that the Hessian Fly has been very abundant for two years. In ordinary outbreaks, two

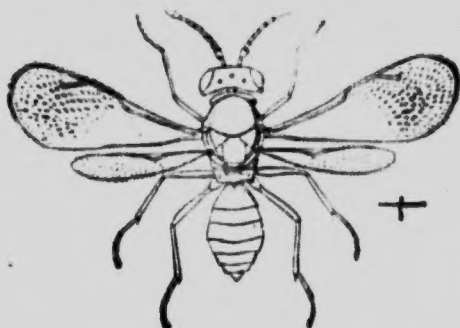


Fig. 6.—*Merisus destructor* (from Riley).
The hair-lines beside each figure indicate the actual size of the insects.

Hessian Fly has been very abundant for two years. In ordinary outbreaks, two

years are usually sufficient time for parasites to develop in large numbers. The forms identified were *Merisus destructor* (Fig. 6), and *Eupelmus allynii* (Fig. 7).

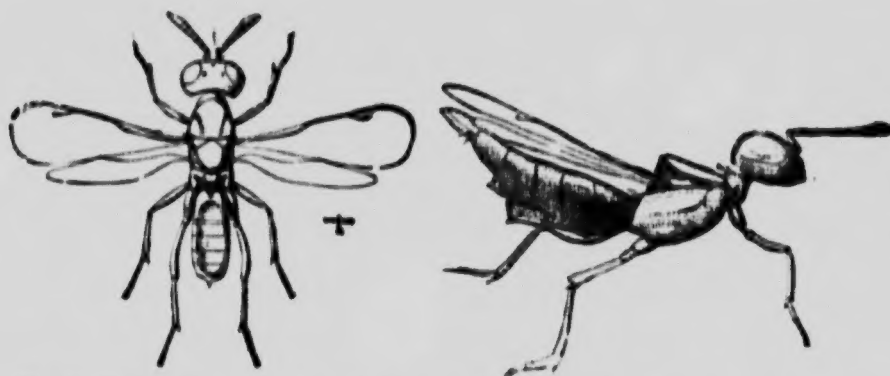


Fig. 7.—*Eupelmus allynii*, male (after Riley). *Eupelmus allynii*, female (from Riley).

However valuable parasites may be in limiting the numbers of the Hessian Fly, and however effective and useful they may be where other preventives are neglected, they can never take the place of active measures, if perfect immunity is desired. A prominent authority states that "but for its natural enemies the Hessian Fly would render it impossible to grow wheat successfully in many sections of the United States."

INSECTS SOMETIMES MISTAKEN FOR THE HESSIAN FLY.

The following insects are frequently mistaken for the Hessian Fly:

American Frit Fly (*Oscinis carbonaria*), Wheat Stem Maggot or Wheat Bulb-Worm (*Meromyza Americana*) (Fig. 8), and Wheat Midge (*Diplosis tritici*) (Fig. 9). Although these are quite unlike in appearance, yet many wheat growers are unable to identify them with any degree of certainty. In order that correspondents may be the better able to name the common wheat pests, a table of characteristic differences between the forms, sufficient for identification purposes, is here given. I am much indebted for the chief characteristics of the forms described to the valuable reports of Dr. Fletcher, of the Dominion Experimental Farm, Ottawa.

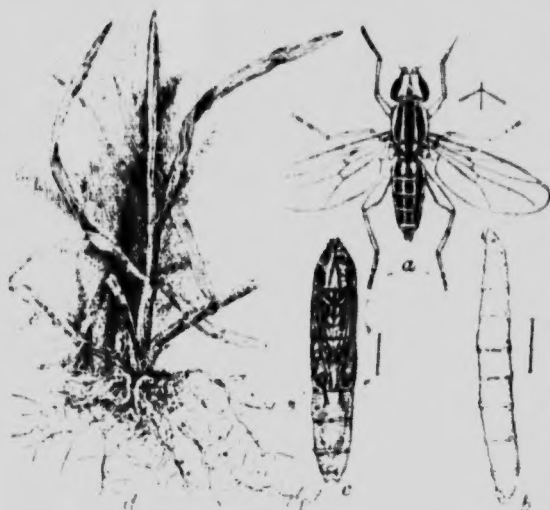


Fig. 8.—Wheat bulb-worm (*Meromyza Americana*): a, mature fly; b, larva; c, puparium; d, infested wheat stem—all enlarged except d (Marlatt).

FOUR INSECT ENEMIES OF GROWING WHEAT.

Name of Insect.	Maggot Stage.	Pupal Stage.	Adult Stage.	Effect on Crop.
American Frit Fly..	Maggot long and slender, yellowish white, with two small but distinct hook-like jaws, and two little knob-like processes on the last segment of body. Length 1-12th of an inch.	Pupa-case, cigar-shaped, and pale chestnut brown.	Colors, black and yellowish white. A small insect not more than one-fifteenth of an inch in length.	Centre of young shoot destroyed at the ground in the autumn.
Wheat-Stem Maggot or Wheat Bulb-Worm	In shape and structure, like that of Frit-Fly, but is of a clear glassy, green color; also much larger, one-quarter of an inch long when full grown. (Fig. 8, b.)	Pupa-case, translucent pale green. (Fig. 8, c.)	Fly is slender, yellowish green, one-fifth of an inch long, with three dark lines extending down the back. Eyes, golden green. (Fig. 8, a.)	In autumn central portion of stem cut off, causing central blade to discolor and die. In summer produces the silver tops or "white heads;" greenish maggots in stem just above top joint.
Wheat Midge	Maggot short, oval in shape, one-twelfth of an inch long when full grown; color, orange yellow. (Fig. 9, c.)	Pupa-cases, small, in the ground, about the size of a mustard seed.	A minute fly, one-tenth of an inch in length, color varying from orange to yellow, but smoky-tinged on the back above the wings. (Fig. 9, a, b)	The orange colored maggots feeding on the grains in the young heads, causing them to shrivel and to fill imperfectly.
Hessian Fly.....	Maggot proportionately much broader than those of Frit-Fly and Wheat-Stem Maggot; clear white, and nearly always shows a green stripe down the middle. The larva within the flax-seed has a horny-forked organ called the "breast bone" Length one-eighth of an inch when full grown. (Figs. 1, d, and 2, c.)	Pupa-cases, deep rich brown, like small flax-seeds. (Figs. 1, e, and 2, f.)	A delicate, dusky fly, one-eighth of an inch in length, and about half the size of a mosquito. (Figs 1, a, b, and 2, e.)	In autumn the young wheat plants become brown and yellow. Whitish maggots and flax-seeds imbedded in the stem at the crown of the root. In summer the maggots and flax-seeds are usually found at first or second joint from the ground. Injured stalks often bend over.

THE FOOD PLANTS OF THE HESSIAN FLY.

Wheat, rye, and barley have for a long time been recognized as the distinctive food plants of the Hessian Fly; but it has been asserted recently, by some observers, that it can live on certain grasses, viz, timothy, couch-grass,

wild rye grass, and a species of chess. It is, however, generally conceded that the insect found on these grasses is not the Hessian Fly but a closely related species.

While precise experimental evidence in every case may be desirable, we have the general fact that throughout an immense territory in the United States where wheat is grown in close proximity to oats, timothy, and other grasses, we have never had a record of the Hessian Fly's attack upon these crops. In view of this fact we may safely conclude that *Wheat, rye, and barley are the normal and only food plants of this insect.*

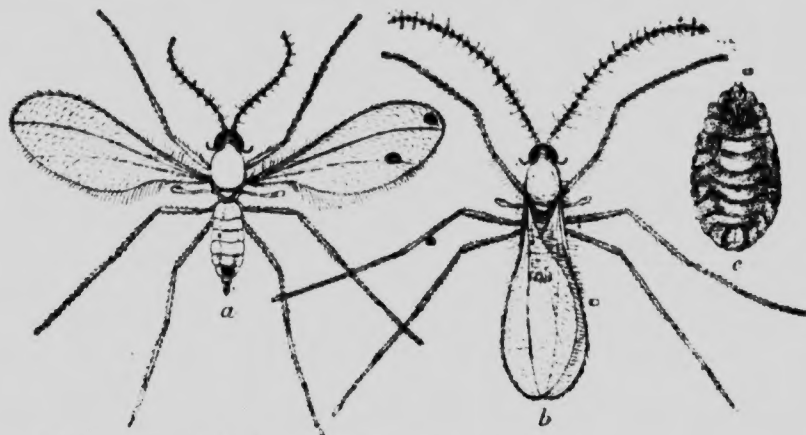


Fig. 9.—Wheat midge (*Diplosis tritici*): a, female fly; b, male fly; c, larva, ventral view—all enlarged. Marlatt.)

REMEDIAL TREATMENT.

When once a field of wheat becomes seriously infested little or nothing can be done to save the crop; and it is often the wisest plan to plow it under and use the land for some other crop. Where there is a good catch of clover very few farmers, however, care to plow under. When the field is but slightly infested, a prompt application of some fertilizer, such as nitrate of soda, will often cause the young plants to send out stools or tillers which are unaffected by the fly. In this way good average crops are often obtained, even when the central shoots have been killed.

The farmer's efforts should lie along the line of prevention of infection of his crop. Several methods of control have been in use for many years, all of which are valuable under conditions which enable them to be carried out:

1. LATE SOWING.—Unquestionably the time of sowing is a very important factor in preventing the attack of the Hessian Fly. If sowing is postponed until the flies have deposited their eggs, then it is almost impossible for the fields to become infested in the fall, unless from belated flies which did not emerge from the "flax-seeds" at the usual time. Observations, however, go to show that climatic conditions influence to some extent the time of appearance of the flies after harvest; and the last two seasons furnished ample evidence on this point. The summers of 1899 and 1900 were very dry, with no rain fall of any account until the last of August. The result of such a drouth was the postponement of the emergence of the flies until the middle of September, or rather, the continuous emergence of the flies from the first week to the middle of the fourth week in September in

many localities; so that wheat sown between the first and twenty-first of September became infected. The majority of the flies appeared about the middle of September; consequently, wheat sown after that date suffered less than that sown before.

It is true that the best time to sow fall wheat in Ontario is the first week in September, in case there are no disturbing factors such as the Hessian Fly; but it is also evident that such fields run greater risk of infection than fields sown, say two weeks later. On this point, Dr. Fletcher makes the following pertinent remarks: (Report 1900, p 199).

"For many years previous to 1899 the Hessian Fly has done very little harm in Canada to fall wheat, and as a result of a great many experiments which are being carried out every year by the members of the Ontario Experimental Union, and other progressive farmers, it had become well known that the best crops were reaped from fall wheat sown at or before September 1. This, therefore, had given rise to the opinion that the proper time to sow fall wheat was at or about the date mentioned. This, however, is only true in such seasons and localities as the Hessian Fly and Wheat-stem Maggot are not abundant; but in periods when these two serious enemies increase, as has been the case during the present season and last year, it will be found that the proper season to sow fall wheat and rye is subsequent to the time when the egg-laying females of the autumn broods of both of these insects have disappeared. For a year or two, at any rate, it will certainly pay farmers to acquaint themselves better with the life histories of these insects and the remedies which have been found successful in preventing the losses due to their attacks."

The date of emergence of the Flies is also dependent on latitude and geographical position, so that the safe time for sowing must be determined for each locality separately. Prof. Webster, of Ohio, has shown that "the dates after which sowing may be safely undertaken in the State of Ohio vary over a period of at least a month from the northern latitudes of the State to the southern latitudes; or from approximately Sept. 10th in the north to October 10th in the south. Wheat sown after the dates mentioned, or after intervening dates in intervening latitudes, will germinate in normal seasons after the Hessian Fly has disappeared, and be free from attack."

Just how far the dates of safe sowing in the various localities in Ontario may vary is not definitely known; nevertheless some progress has been made the last two seasons along this line. It seems not safe to sow, in ordinary seasons, before September 15th in the counties bordering on Lake Erie, and the tract of land occupying the Valley of the Thames. In the next row of counties, including Lambton, North Middlesex, Oxford, Brant, Wentworth, and those bordering on Lake Ontario, the probable safe date would be September 10th; while in the counties farther north, the safe date may be placed at September 5th. (See map).

The farmer, if he wishes to grow wheat free from the fly, must follow the season rather than the almanac, for the best date for one season may not be the best for another. For instance, a rainless August, such as we had in 1899 and 1900, will retard the emergence of the flies fully two weeks; but an August with a considerable rain-fall during the last two weeks will bring forth the flies about the first week of September to deposit their eggs,—in which case it will be quite safe to sow according to the dates given above.

2. LAND WELL PREPARED FOR THE SEED.—Next to late sowing the preparation of the soil is probably the most important factor in fighting the Hessian Fly. The ground should be plowed early, and a good, rich, smooth,

well-pulverized seed-bed be secured ; and, besides, only the best seed wheat that can be procured should be sown. These factors are becoming fairly well recognized so far as the yield in ordinary seasons is concerned, but few as yet are aware how important good farming is in preventing injuries by the Hessian



Map of Ontario, showing the area of infestation by Hessian Fly. Note the safe dates for sowing in the three belts.
(Original.)

Fly. Prof. Webster, after fifteen years of study of the Hessian Fly, says: "I am satisfied that four-fifths of its injuries may be prevented by a better system of agriculture. For years I have seen wheat grown on one side of a division fence without the loss of a bushel by attack of this pest, while on the other side the crop was almost invariably more or less injured. No effect of climate, meteorological conditions, or natural enemies could have brought about such a contrast of results. The whole secret was in the management of the soil and the seeding."

Prof. Roberts, of Cornell University, also attaches special importance to the preparation of the land in combating the Hessian Fly. He says: "Much stress should be laid on the proper fitting of the land for wheat. Plowing should be done early, at least six weeks before sowing, to give abundant time for repeated working of the soil in order to recompact the sub-surface soil, and secure a fine, but shallow, seed-bed in which there has been developed by the tillage and action of the atmosphere an abundance of readily available plant food. Manures and fertilizers should be kept near the surface, and the young roots encouraged to spread out in the surface soil, thus avoiding much of the damage by heaving in winter and leaving the deeper soil for a fresh pasturage for the plants during the following spring and summer."

The same writer, after a long experience with the Hessian Fly, comes to the following conclusions: 1st. That wheat raising need not be abandoned but the number of acres should be reduced until by reason of such reduction every acre sown will be raised under superior conditions. 2nd. That the soil must be so well fitted and so fertile that a strong healthy growth will be secured in the fall, though the sowing of the seed be delayed 10 to 15 days beyond the usual time. Such preparation of the soil will also help the wheat to recover from any winter injury. 3rd. That the Hessian Fly injures the wheat more on dryish and poor land than on moist, but well drained, rich soil. 4th. That thick seeding and vigorous growth tend to ward off the Fly." (Cornell Bulletin 194, 1901).

Several of our own most progressive farmers corroborate the views of the two eminent authorities already quoted. Mr. E. D. Tillson, Oxford Co., says: "It is useless to endeavor to kill out the Hessian Fly by ceasing to grow wheat, as all farmers cannot be induced to do so. In this section the farmers who sowed good seed on well prepared land got fair crops even this year; while many careless ones did not get their seed back. Vigorous, strong growing wheat will withstand the fly, whether sown early or late." (*Farmers' Advocate*)

Mr. John Jackson, Lincoln Co., says: "In the district infected with the Hessian Fly. I think the acreage should be very much reduced, confined to what land can be put in the very best condition, and thoroughly well manured to insure a strong and vigorous growth. Extreme dates, and between which it would be safe to sow, are 8th of September to 8th of October. I would prefer from 10th to 20th of September." (*Farmer's Advocate*)

Mr. Jas. Mayhew, Kent Co., says: "Wheat sown in the same field on the same day and from the same seed, where there was a variety of soils, gave very different results according to the nature of the ground. The low or moist ground gave a fair half crop, while the wheat was entirely killed off on the dry ground. Our observations lead to the belief that want of fertility has largely to do with the amount of destruction caused by the Fly."

Mr. Alex. F. Ross, North Middlesex, says: "We have a field of wheat which was badly down with the Hessian Fly, but we have one piece in the field which did not have any Fly in it. It was an old barnyard cropped for four or five years."

Mr. H. J. Stevens, Kent Co., says: "So far as we have been able to find out, it has not been so much the kind of wheat as the locality and the condition the wheat was in. Sandy land has suffered most. This with early wheat is where the most damage is done."

Notes on Cultivation for Winter Wheat. At my request Prof. G. E. Day, of the Ontario Agricultural College, has prepared a short section dealing with the proper cultivation of land for winter wheat. I feel sure that this portion of the bulletin will be carefully read.

Owing to the fact that winter wheat is grown under such varying conditions as regards place in rotation, character of soil, etc., it is impossible to discuss all the phases of the question of cultivation. All that will be attempted, therefore, is the presentation of a few notes on methods that have proved successful. In the first place, it is generally admitted that winter wheat requires a soil comparatively compact below, mellow, and rich in available plant food near the surface, and possessing enough moisture to germinate the seed quickly. To secure this condition, various methods are adopted, and probably the oldest and best known of these is the

Summer Fallow.—Economy not considered, the summer fallow is perhaps the most effective way of preparing a fine seed-bed for winter wheat. The frequent cultivation allows air and bacteria to do their work in making plant food available, and also permits the accumulation of an abundant supply of moisture in the soil to help push the crop forward. It is a mistake, however, to plow a fallow frequently, because the most available plant food is near the surface. What plowing is done, should be performed early in the season, and practically all subsequent cultivation should be restricted to merely loosening the surface to a depth of not more than three or four inches.

The fallow, however, is an expensive method of preparing the ground for wheat, and on any reasonably well cultivated and fertile soil good crops of wheat can be grown without resorting to such an expensive process. Wheat is grown after a great variety of crops, but perhaps the two best crops to precede wheat are clover and peas. Both these crops are nitrogen collectors, and leave the surface soil comparatively rich in this important element, clover being particularly valuable in this respect.

Wheat after Clover.—The clover sod should be plowed before Aug. 1st, and if there is a good second growth to turn under, all the better. It should be plowed about $4\frac{1}{2}$ inches deep, using a skimmer, or chain, or both, to turn everything under. Immediately after plowing, the land is rolled to compact it, and then thoroughly harrowed to pulverize the surface and fill in all spaces between the furrows. Land treated in this way will absorb and retain moisture, and in a very short time the sod will rot. All that is necessary after this is an occasional stirring of the surface soil with a spring tooth cultivator. If weeds appear, broad points should be used on the cultivator. When it is time to sow the wheat, the soil will be found mellow, moist, and rich in available plant food.

Wheat after Peas.—In this plan it is best to have the peas follow sod, the sod being plowed early in the fall and thoroughly harrowed and cultivated. A plan that has given excellent results is to manure the ground during the winter or early spring before the peas are sown. This manure should be merely gang-plowed under in the spring, keeping it as near the surface as possible; and it does not matter if the manure is not rotted before it is applied. By the time the peas are harvested, the manure is thoroughly decomposed and incorporated with the surface soil. Immediately after the peas are harvested, the land should be either gang-plowed or cultivated, then harrowed and allowed to lie until it accumulates sufficient moisture to germinate the seed, when it may be prepared for sowing. When the land is clean, a seed-bed can be prepared without either plowing or gang-plowing, the cultivator alone being used. If there are many annual weeds among the peas, the ground may be worked up with the spring tooth cultivator and harrowed immediately after harvest, and then allowed to lie for a week or two to encourage as many weed seeds as possible to germinate; then the ground may be gang-plowed before the wheat is sowed.

The advantage of applying manure before the peas are sown is obvious. When manure is applied after harvest, just before sowing wheat, it is difficult to incorporate it with the soil, because at that time the soil is comparatively dry, and the manure is apt to lie in the soil in an inert condition. It also makes the soil more open than it otherwise would be, and lessens its water-holding capacity, because the manure and soil are not well mixed. When the manure is mixed with the soil in the spring, however, it becomes thoroughly incorporated with the soil during the summer, and being kept at the surface, it forms a surface layer, rich in vegetable matter that is easily worked into a fine seed-bed in the fall.

Concluding Remarks.—As stated before, it is impossible to give directions for all possible conditions. Enough has been said, however, to indicate in a general way how to go about securing a moist and mellow seed-bed for the wheat. It is better in all cases to delay sowing until a somewhat later date, than to sow the seed in an extremely dry soil. When sown in a very dry soil, wheat germinates irregularly, and the plants are comparatively weak, slow-growing, and very liable to attacks by insects. A late vigorous growth is much better than an early, but weak, growth. To get the best results, both in the way of obtaining available plant food and abundant moisture, manure should be applied at least a month before the crop is sown, so as to insure thorough mixing of the soil and manure, and prevent the undue opening up and consequent drying out of the soil. The application of manure with the crop which precedes wheat, as described above, has many advantages, and, on the whole, is to be preferred wherever it is practicable.

3. **TRAP CROPS.**—The planting of trap strips of wheat about the middle of August in the field set apart for the wheat crop has been found very valuable wherever tried. The flies are attracted to the strips of wheat to lay their eggs; while later on the strips are plowed under deep and the entire brood destroyed. Trap crops are valuable for another reason. The farmer can ascertain for himself when the flies have ceased to deposit eggs and the safe time to begin sowing his seed wheat.

Moreover, if any of the supplemental fall brood appear before the usual time, the trap crop will attract them, and the young larvæ can be destroyed; otherwise, the eggs are laid on volunteer wheat and barley, to which no attention is usually given, and thus the brood is perpetuated. A trap crop should be destroyed within four weeks from time of sowing and plowed under so deeply that none of the flies in maturing will escape.

4. **THE BURNING OF REFUSE.**—Mention has already been made of the fact that the "flax-seeds" are frequently found higher than usual on the stem, viz., above the first joint from the ground, and that they are carried to the barn in the straw. During the threshing of the grain, the "flax-seeds" are separated in the chaff and screenings. It becomes, therefore, an important point to have all the dust and screenings destroyed, and to burn as much of the refuse as practicable, or to feed the screenings as early as possible to the stock.

5. **THE BURNING OF THE STUBBLE.**—As most of the "flax seeds" remain on the stubble after harvest, the practice of burning the stubble has for many years been one of the standard measures taken against the fly. This practice, however, is not a practicable one with most of our Ontario farmers, on account of the practice of seeding to grass and clover. The burning of the stubble would destroy the young meadow plants.

In some wheat districts the plowing under of the stubble is recommended when burning is impracticable. This method is a most effective one when it can be carried out properly and the stubble turned down to a depth of several inches and the field rolled. Unfortunately, however, this method is impracticable in Ontario, for the reason given above against the burning of the stubble. Whenever either of these methods become practicable, the stubble should be dealt with some time in August, before the flies appear to lay their eggs for the autumn brood.

FLY-PROOF VARIETIES OF WHEAT.

It is doubtful if there is any truly fly-proof variety of wheat in existence, but there are apparently certain varieties which are not injured so much as others. In the Experimental Plots at the Ontario Agricultural College, the Imperial Amber, Egyptian Amber, Michigan Amber, and Early Genesee Giant were but slightly infested; while the Dawson's Golden Chaff, Turkey Red, Buda Peath, Clawson, Treadwell, and Red Chaff were badly damaged. At Thamesville, Kent Co., the Niger and Egyptian suffered least; while around Woodstock, the Red Bearded Walker's Reliable gave the best results when threshed. "In Stephen Tp., Huron Co.," H. Eilber, Esq., M.P.P., writes me, "Michigan Amber, and American Brand have stood the fly best." The Genesee Giant and Arcadian, also, as a rule, gave fairly good returns in most localities. Throughout the infested areas, Dawson's Golden Chaff suffered very severely, and will not yield more than one third of an average crop.

In New York State, however, Dawson's Golden Chaff proved to be almost fly-proof, and, in almost every instance, gave good results. Prof. Roberts says: "It is difficult to explain why Dawson wheat should be so free from damage from the Fly in New York and not in Canada, the place of its origin; neither can we tell what characteristics enable one variety to resist while another succumbs. Vigor of growth, no doubt, exerts much influence, but not all." The other resistant varieties in New York State are Prosperity, No. 8, Democrat, Red Russian, and White Chaff Mediterranean.

CO-OPERATION OF THE FARMERS IS NECESSARY.

In dealing with most insect pests, and especially with the Hessian Fly, it is very important that all the farmers in the locality should co-operate in the matter. Everyone should sow as late as practicable, and as near the same time as possible, for if some fields are sown early, they may easily supply flies enough in the spring to infest all the neighboring fields. This fact was very noticeable this year; for fields which were free from the fly last fall, were badly damaged before harvest. Several correspondents, unacquainted with the life history and habits of the fly, maintained that it made no appreciable difference whether wheat was sown late or early. One well-informed Middlesex correspondent, however, writes me on this matter as follows: "I plowed up 15 acres Gold Coin last spring, and kept Dawson's Golden Chaff, which you saw; and it then was comparatively speaking pretty free; but my neighbors, however, supplied me with plenty of breeding stock with the result of my having only 14 bushels per acre, the biggest yield yet announced in this neighborhood. I think the average will not exceed 5 bushels for two or three townships."

In conclusion, it may be stated frankly that there are many peculiar features in connection with the Hessian Fly which have not yet been ex-

plained, or else are difficult to explain, and that many more careful observations will have to be made before everything is known regarding the life-history of the pest. Among these peculiar features connected with the Hessian Fly I may be permitted to mention some which I observed while making investigations in the infested wheat fields in the spring of this year. I frequently found early sown fields infested to a less extent than those sown later. However, a probable explanation suggested itself; the fields were sown before the emergence of the fly, and the wheat plants had attained a good growth before the maggots made their appearance. The more tender plants of the later sown fields were more attractive to the flies, and the consequence was the deposition of the eggs on the younger plants. Again, I observed in one or two localities, where seeding was done about the same time, but too early to escape the fly, that one or two fields were almost free from infestation. The only cause I could assign for this peculiarity was the presence of woods which nearly surrounded the fields free from infestation. And again, fields on the leeward side of old stubble-infested fields were often comparatively free from the fly, while those on the windward side were badly infested. In these cases the wind was very probably the distributing factor. These observations, I may repeat, were made before the spring brood had an opportunity to make itself felt.

SUMMARY.

1. The Hessian Fly is double-brooded,—the fall brood appearing in September and injuring the young plants of fall wheat; the spring brood appearing in May and June and injuring the more mature stage of the fall wheat as well as spring wheat and barley.

2. For the present, its ravages are confined chiefly to the south-western counties of the Province.

3. Parasites which prey upon the Hessian Fly are apparently few in number, and are doing but little to keep the pest in check.

4. The best preventive measures are (a) late sowing, (b) thorough preparation of the land (c) stimulation by fertilizers, (d) trap crops, (e) burning of refuse after threshing, and (f) burning or plowing under of infested stubble when practicable, (g) co-operation among the farmers themselves.

5. There is no absolutely fly-proof variety of wheat. The Genesee Giant, Arcadian, Walker's Reliable, Michigan Amber, and Egyptian Amber suffered less than Dawson's Golden Chaff, Turkey Red, or Democrat.

6. Climatic conditions influence the time of appearance of the fly in the autumn. A dry rainless August will retard the appearance sometimes ten days or two weeks. In normal seasons, with rain during the last two weeks in August, the safe date for sowing varies in different localities, from Sept. 5th in northern counties to Sept. 15th in the counties along Lake Erie. (See map.)

It cannot be emphasized too strongly that, in order to obtain the best practical results, total reliance should not be placed on any one of the methods outlined above; but, instead, an intelligent combination of two or more of the measures should be adopted.

"Sow as late as your local conditions will permit, sow intelligently in a well-prepared seed-bed and on good soil, get your neighbors to do the same, and you will circumvent the Hessian Fly nearly every time." (Slingerland.)